

Research Report

The effect of soda immersion on nano hybrid composite resin discoloration

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ABSTRACT

Background: Composite resin is the tooth-colored restorative material which most of the people are fond of due to their aesthetic value. The composite resin discoloration may happen because of the intrinsic and extrinsic factors. Soda water is one of the beverages which can cause the composite resin discoloration. **Purpose:** The study was aimed to determine the effect of soda immersion on nano hybrid composite resin discoloration. **Methods:** The study was an experimental laboratory study using 100 shade A3 nano hybrid composite resin specimens with the diameter of 5 mm and density of 2mm. The samples were divided into 5 groups, each group was immersed in different beverages. The beverages were mineral water; lemon-flavored soda; strawberry-flavored soda; fruit punch-flavored soda; and orange-flavored soda for 3, 7, 14 and 21 days respectively, in the temperature of 37° C. The discoloration measurement utilizes Spectrophotometer, Vita Easy Shade, and uses CIEL*a*b* method. **Results:** The result showed that the duration of immersion in soda had an effect on the Nano hybrid composite resin discoloration. Strawberry and fruit punch- flavored soda were the most influential components toward the discoloration. Nevertheless, the generally-occurred discoloration was clinically acceptable ($\Delta E \leq 3,3$). **Conclusion:** The study suggested that the soda immersion duration has effect on Nano hybrid composite resin discoloration.

Key words: Nano hybrid composite, discoloration, soda beverages

ABSTRAK

Latar belakang: Resin komposit adalah material berwarna gigi yang diminati masyarakat karena memiliki nilai estetika yang baik. Perubahan warna resin komposit dapat terjadi karena faktor intrinsik dan ekstrinsik. Minuman soda merupakan salah satu minuman yang dapat menyebabkan perubahan warna pada resin komposit. **Tujuan:** Tujuan dari penelitian ini untuk meneliti perubahan warna resin komposit nanohibrida akibat perendaman dalam minuman soda. **Metode:** Metode yang digunakan pada penelitian ini adalah eksperimen laboratorium dengan menggunakan 100 spesimen resin komposit nanohibrida shade A3 berdiameter 5 mm dan tebal 2 mm. Sampel dibagi dalam 5 kelompok, masing-masing kelompok direndam dalam minuman yang berbeda, yaitu direndam dalam air mineral, soda lemon, soda strawberi, soda fruitpunch, dan soda jeruk selama 3, 7, 14 dan 21 hari, dalam suhu 37° C. Pengukuran perubahan warna menggunakan Spectrophotometer, Vita Easy Shade dengan metode CIEL*a*b*. **Hasil:** Hasil penelitian menunjukkan bahwa lama perendaman pada minuman soda berpengaruh terhadap perubahan warna resin komposit nanohibrida. Soda yang paling berpengaruh terhadap perubahan warna adalah soda strawberi dan soda fruitpunch. Namun perubahan warna yang terjadi secara umum masih dapat diterima secara klinis ($\Delta E \leq 3,3$). **Simpulan:** Hasil penelitian ini menunjukkan bahwa lamanya waktu perendaman mempengaruhi perubahan warna pada resin komposit nanohibrida.

Kata kunci: Komposit nanohibrida, perubahan warna, minuman soda

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INTRODUCTION

Soda is the carbonated water which has various flavors and colors that can attract people to consume.¹ It is proven by American Academy of Pediatrics that reported 56-85% of students consume soda at least once a day. This percentage increases on teenage boys, 20% of them consume it at least four times a day.² People's habit to consume soda, which actually contains various dye substances, can affect the discoloration of their composite resin restoration.³ In his previous experiment, Al-Shalan⁴ proposed that there is composite resin discoloration after immersing into the coffee, tea, and wine. It is supported by Chong *et al.*² that consuming coffee, tea, soft drink (soda water), juice, and liquor may influence composite resin aesthetic and physical quality. Wan Bakar *et al.*⁵ once noted that the discoloration may be caused by the absorption from staining substances such as wine, coffee, tea, and cola (soda).

Composite resin is often used as restorative materials in dentistry due to its high aesthetic value. Composite resin are able to produce restoration color which is identical to original tooth color.⁵ Tyas⁶ reported the survey result toward 100 restoration users-55% use composite resins, 28% use amalgam, 15% use GIC, and 2% use polyacid-modified composite resin. Nano hybrid composite resin has better physical and mechanical value rather than the conventional composite resin. According to Al-Shalan,⁴ nano hybrid composite resin have many advantages, that they can be used for anterior and posterior tooth restoration and reduce the shrinking during polymerization. Moreover, they also have smoother surface due to their nano particles, better mechanical and aesthetic quality, and they are also suitable for restoration on anterior teeth. As according to Wan Bakar *et al.*,⁵ the lack of composite resin is that their color is changed while exposed to other dye substances; whereas the most important role of composite resin as the high aesthetic valued-restoration depends on the color suitability among others.⁷

The discoloration may occur due to the intrinsic and extrinsic factors. The intrinsic factor derived from the composite resin itself, which occurs in the matrix resins or between the matrix gap and filler, while the extrinsic factor comes from plaque accumulation and staining caused by color substances penetration and exogenous contamination. The degree of exogenous discoloration is influenced by oral hygiene, food and beverages consumed, and smoking habit. Furthermore, discoloration may occur chemically, which relates to the alteration or oxidation on amine accelerator, oxidation of polymer matrix structure and methacrylate group.⁸

Soda not only contains dye substance but also contains sugar and has low pH. The sugar in it can increase the color change in composite resin restoration material, while low pH (2.7) can influence the softening matrix in composite resin, so that it will affect on composite resin's integrity.³ The

existence of microcracks and microvoids between the filler and matrix resin can be the entrance for the dye substance to penetrate into the composite resin.⁴ Toksoy *et al.*⁹ supported that dye substance penetration causes the discoloration of composite resin from yellow to brownish.

More than 80% of patients are anxious about discoloration in the composite resin restoration they use. This discoloration is one of the reasons to replace the composite resin restoration. The previous study reported that the discoloration starts from the 1st up to the 2nd week since the composite resin is exposed to the beverages.⁴ Nevertheless, the discoloration has not been examined up to the 3rd week. The study was aimed to determine the effect of soda immersion on nano hybrid composite resin discoloration.

MATERIALS AND METHODS

This study was an experimental laboratory using 100 plates of Nano hybrid composite resin mono ceram X dentsply® shade A3 which were immersed in mineral water and various kinds of flavored soda (lemon, strawberry, fruit punch, and orange) for 3, 7, 14 and 21 days in the temperature of 37⁰ C. The discoloration is measured using CIEL *a*b method. The tool used to measure the discoloration was *Vita Easy Shade Guide*, which results in numbers to present the colors. Colors component measured were as follows: (1) L* or Lightness, the range of value 0 (black) to 100 (white); (2) a* was a chroma component, which the discoloration was indicated by +a* to show reddish color and -a* to show greenish color; (3) b* was chroma component, which indicates +b* as yellowish and -b* as bluish.

The formula of discoloration:

$$\Delta E = \{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2\}^{1/2}$$

Note:

- ΔE : discoloration
- ΔL : black-white ($L_2 - L_1$)
- Δa : color differences from red-green ($a_2 - a_1$)
- Δb : color differences from yellow-blue ($b_2 - b_1$)

The straws were cut into 2 mm in height to make composite resin plates. After that, apply nano hybrid composite resin using plastic filling. Then, it was polymerized using the light cured for 20 seconds. All the specimens were immersed in distilled water for 24 hours in order to be perfectly polymerized in the temperature of 37⁰ C to stimulate the mouth cavity temperature. After being immersed by the distilled water, the specimens were dried with tissue. Then, the initial measurement was done to the composite resin using white paper as the base. Specimens were immersed in each flavored-beverages and mineral water for 3, 7, 14 and 21 days respectively. The flavored-

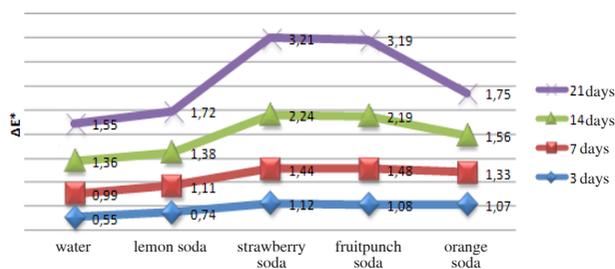


Figure 1. Graphic of discoloration.

beverages (lemon, strawberry, orange, and fruit punch soda) were changed daily. Measure specimens' colors on the 3rd, 7th, 14th and 21st day after the first immersion.

RESULTS

The effect of immersion duration toward the composite resin discoloration after being immersed in various colored and flavored soda was evaluated using statistical analysis repeated measures Anova with significance level of 0.05 ($p = 0,05$) and confidence level of 95% ($\alpha = 0.05$). The difference of nano hybrid composite resin discoloration due to the consumption of various colored and flavored soda water was evaluated using one way Anova statistical technique with significance level of 0.05 and confidence level of 95% ($\alpha = 0.05$). The result of *Repeates Measures* Anova test showed that the significance level got from the calculating process was lesser than $\alpha = 0,05$. So, it could be concluded that the duration of immersion in various colored and flavored soda water (mineral water, lemon, strawberry, fruit punch, and orange soda water) influences Nano hybrid composite resin discoloration significantly.

The result of one way Anova Test shows that the significance level obtained from the calculating process was less than $\alpha = 0,05$. There was nano hybrid composite resin discoloration as the effect of consuming various colored and flavored soda. Strawberry and fruit punch- flavored soda were the most influential components toward the discoloration.

DISCUSSION

ΔE^* result on control group (immersed in mineral water) from days 3-21 indicates a range of value between 0.62-1.36. The discoloration increases in accordance with immersion duration, yet the discoloration on the 14th and 21st day did not differ significantly. It is corresponds to Al-Shalan⁴ that the discoloration occurs from the first week of exposure and increases until the second week. ΔL^* result on control group day 3 until 21 indicates the blackened composite resin which is marked by the decreasing of white spectrum (L^*) degree during 21 days. The decreasing of

color spectrum also occurs on Δa^* dan Δb^* . The immersion in mineral water only visually noticeable changes started from the 14th day, which is $\Delta E \geq 1$. Yet, it was still clinically acceptable. It is also happened in Fontes *et al.*¹⁰ that stated that after nano filler resin immersion in water for a week did not indicate any significant discoloration or it was still clinically acceptable. The discoloration may occur chemically related to the change or oxidation of amine accelerator, oxidation of polymer matrix structure, and oxidation of methacrylate group.

The immersion in lemon soda indicates an increase in discoloration (ΔE^*), which is in accordance with immersion duration. The increasing of discoloration in lemon soda indicates the different result among the other immersion group. Composite resin immersion in lemon soda causes an increase in degree of white color significantly (visually noticeable) begun on day 7 to 21 ($\Delta L^* = 1.05 - 1.79$). It is due to the acid properties which have erosive effect to polymer material degradation and color pigment on composite resin (ferric oxide).

The acid properties of soda water can dissolve polymer matrix of composite resin which causes white color appearance comes from silica powder contained in composite resin. Likewise in Δa^* dan Δb^* , there is an increase in accordance with immersion duration, the composite resin is heading to red and yellow. The range of composite resin discoloration caused by immersion in lemon soda is 0.62-1.79. The experiment result shows the quite significant discoloration in each immersion duration, however, the discoloration is small and still clinically acceptable ($\Delta E \leq 3.3$).

The discoloration caused by strawberry soda can be seen from ΔE which is noticeable on 3rd, 7th, 14th, and 21st day with value range of 1.02-3.52. Color spectrum change that mostly affects ΔE value showed by Δa^* value (reddish) which is higher rather than ΔL^* and Δb^* value from 1st until 21st day. This change indicates an increase of red spectrum degree which is caused by red pigment in strawberry soda. The Nano hybrid composite resin discoloration may berelatedto resin' ability to absorb or adsorb color pigment in assorted soda colors and flavors.¹¹ It is also concluded by Burrow and Makinson that composite resin discoloration is more visible due to absorption from colored-food rather than water. Based on the experiment result, there is a significant change in each immersion duration, yet there are only 2 samples at the 21st day which the changes are clinically acceptable, which is more than clinically acceptable maximum criteria ($\Delta E \geq 3.3$). Discoloration in strawberry soda is more than other soda water since it has very condensed color pigment. It can be proven from the left red stain in lips and tongue after consuming strawberry soda.

Nano hybrid composite resin discoloration range (ΔE) after being immersed in fruit punch soda is 0.9-3.39. This discoloration ΔE^* is highly influenced by ΔL^* , Δa^* , dan Δb^* values which continuously decrease after immersion. This condition indicates the discoloration proven by the

decreasing of white, red, and yellow spectrum degree in the Nano hybrid composite resin to the dark colors- green and blue. Based on the experiment, there is a still clinically acceptable significant discoloration of each immersion duration. There is only 1 sample at the 21st day which experiences discoloration more than 3.3. This is caused by the concentrated green pigment in fruit punch soda. It is proven by the left green stain in lips and tongue after consuming it. Generally, composite resin's color stability is affected by various factors such as matrix resin, initiator concentration, oxidation of unreacted monomers, filler content, and pigment.¹¹

Discoloration ΔE^* in orange soda is tremendously affected by ΔL^* value decreasing, while Δa^* dan Δb^* increase after immersion. This condition represents discoloration evidenced by degree decreasing of white spectrum and increasing of red and yellow spectrum in Nano hybrid composite resin specimens. Discoloration range on orange soda is 1.02-1.92. It can be known from the experiment that the discoloration is still clinically acceptable despite the significant discoloration of each immersion duration, which keep increasing during 3, 7, 14 and 21 days. This change is caused by orange pigment in orange soda. It is concluded that the increasing of discoloration along with immersion duration indicates pigment exposure toward Nano hybrid composite resin, resulted on the clearer discoloration.

All groups of composite resins immersed in assorted soda colors and flavors undergo quite significant discoloration in accordance with immersion duration. Still, commonly, the discoloration cannot be clinically accepted even though some samples immersed in strawberry and fruit punch show $\Delta E \geq 3.3$. The immersion in mineral water, lemon soda, orange soda, fruit punch soda, and strawberry soda indicates the discoloration sequences from the least to the most. Although nano hybrid composite resin has a good color stability, this experiment proves that there was a significant discoloration from the average value of ΔE^* at 3rd until 21st day. Some researchers stated that $\Delta E^* > 1$ in composite resin shows visually noticeable discoloration, however, up to $\Delta E^* \leq 3,3$ can be clinically acceptable

According to the experiment result, there is a significant discoloration along with nano hybrid composite resin immersion, yet this experiment indicates the smaller ΔE^* value than the previous experiment of Micro hybrid composite resins done by Toksoy Fulya in 2009.

The study suggested that the soda immersion duration has effect on nano hybrid composite resin discoloration. However, the discoloration caused by immersion in lemon and orange soda is still clinically acceptable. Since soda can cause discoloration, the patients who are using composite resins are suggested not to consume too much soda water.

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